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Digital Transformation and IT: Current State of Research

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Completed Research Paper

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Abstract

Information Systems (IS) have never been more important as digital technologies are essential for business model innovation by developing new digital products and services. Digital transformation not only affects business, but also IT. While digital transformation and digital technologies are well established research areas, the implications of digital transformation on IT are rarely in focus. Taking this topic as a reference, the paper contributes to general IS research by assessing to which extent digital innovation is already subject to mainstream IS research. A bibliometric study analyzing all 2,833 articles published in the AIS Senior Scholars' 'basket' of eight leading IS journals between 2007 and 2016 reveals that a mere 0.2% address the impact of digital transformation on IT while 2.3% cover topics of digital transformation, innovation, or digital technologies. In contrast to previous work, this study finds that digital innovation research is already present in primarily high-ranked IS journals.

Keywords: Digital innovation, digital transformation, digital technologies, impact on IT, bibliometric study, digital research agenda, IS research agenda

Introduction

The increasing diffusion of digital technologies is ultimately changing our everyday lives (Yoo 2010); businesses across industries experience quickly changing demands (Priem et al. 2013). Digital transformation refers to a process of major change to enhance customer experience and to innovate on business models by leveraging digital technologies like analytics, cloud computing, internet of things, mobile, or social media (Fitzgerald et al. 2014). Companies develop new products and services with the help of new combinations of digital and physical components in order to stay competitive in the digital era (Yoo 2010). Digital transformation has particularly major impact on IT (Urbach 2016): Chief Information Officers (CIOs) are increasingly riddled with ambiguity (Peppard et al. 2011) and CIO activities are expanding from providing IT services to including external customer responsibilities, working with non-IT colleagues, and managing enterprise processes (Weill and Woerner 2013). Consequently, IT plays a key role in driving innovation but is also heavily affected by digital transformation.

Publications on digital innovation research including aspects of transformation or technology are already covered well by practitioner literature and increasingly by scientific literature. However, research related to the impact of digital technologies on IT addressing questions on the future role of the IT function or how to make an IT department future-proof for the digital economy is still rare (Horlach et al. 2016; Sørensen and Landau 2015). An explanation might be that IS research traditionally has not focused on managerial questions related to the IT function. However, digital transformation receives currently a high attention not only in the CIO community, but also in science and is already well-present on almost any IS-conference or in special issues of IS journals.

This paper addresses the question to which extent digital innovation research and specifically research related to the impact of digital transformation on IT is already present on the mainstream IS research agenda. The impact of digital transformation on IT is taken as an exemplary reference for digital innovation research. Referring to the publications of Sørensen and Landau and Horlach et al. on

digital innovation research, this paper contributes to the debate in IS on its role, status, research contributions, and relevance for practice (Grover and Lyytinen 2015; King and Lyytinen 2006; Lyytinen and King 2006; Sørensen and Landau 2015). Specifically, in times of digital transformation disrupting virtually any industry with new possibilities offered by digital technologies, the IS community needs to take a clear stance regarding its role and contributions to digital innovation research.

This paper presents the findings of a bibliometric study on the extent to which digital innovation research and specifically research regarding the impact of digital transformation on IT is already subject to rigorous academic discussion within the AIS Senior Scholars' 'Basket of eight' leading IS journals ("Basket of eight"). The paper refers to the work of Sørensen and Landau (Sørensen and Landau 2015) and Horlach et al. (Horlach et al. 2016) who have analyzed digital innovation research. Taking topics of mobile Information and Communications Technology (ICT) (Sørensen and Landau) and "bimodal IT" (Horlach et al.) as a reference, a significant gap in attention on topics of digital innovation between science and practice has been identified by Sørensen and Landau.

This bibliometric study reveals that a mere 0.2% of all 2,833 articles published in the "Basket of eight" between 2007 and 2016 address the impact of digital transformation on IT while 2.3% deal with digital innovation research like digital transformation, digital strategy or digital technologies. Contrary to the research of Sørensen and Landau, this study finds that digital topics have been covered recently primarily by highly-ranked US journals.

This paper contributes to IS research in three ways: First, to asses to which extent topics of digital innovation research in general and specifically regarding the impact of digital transformation on IT are already covered by mainstream IS research. Second, to asses of whether the findings of Sørensen and Landau related to digital innovation research are still valid and which recent trends for 2015 and 2016 can be identified. Third, to contribute to the discussion of the current and future role of IS with respect of digital innovation research.

This paper proceeds as follow: Section 'Current State of the IS Research Agenda' gives a brief overview of the discussion on IS research. Section 'Digital Innovation Research' and 'Research on the Impact of Digital Transformation on IT outside the "Basket of Eight"' presents the current state of topic coverage. The section 'Methodology' describes the applied research methodology. Section 'Results' presents the findings from the bibliometric study and section 'Discussion' concludes the findings.

Current State of the IS Research Agenda

According to Agarwal and Lucas, IS would be predestined to conduct research on the transformational impact of IT due to the rapid change of information technology (Agarwal and Lucas Jr 2005). IS would have to tell a "powerful story about the transformational impact of information technology" (Agarwal and Lucas Jr 2005, p. 381). Lyytinen and King see that IS would struggle with itself about the question of its legitimacy (Lyytinen and King 2004). Anxiety about "IS's purported lack of academic legitimacy" would be the consequence (King and Lyytinen 2004, p. 539). Therefore, IS would be more concerned about rigor than relevance resulting in a lack of analyzing topics of practical relevance (Benbasat and Zmud 1999; Hambrick 2007). Lyytinen argues that IS would critically hinge upon technological development (Lyytinen 1999). Understanding the dynamic of digital technologies and digital transformation would necessitate IS research to cover topics like digital infrastructures (Tilson et al. 2010).

As a response, calls for a new IS research agenda to include digital technology adequately can be observed: Yoo argues to "expand our research domain by embracing the ubiquitous impact of computing in everyday life" (Yoo 2010, p. 217). He sees a need to develop "new theoretical models and insights that guide management practices in the age of generativity" (Yoo 2013, p. 227). Tilson et al. propose new directions for IS research as well: They recommend to focus research on topics of digital infrastructure and aspects of "paradoxes of change and control" (Tilson et al. 2010, p. 748). A more recent paper from Grover and Lyytinen postulates that scholars should be more open towards practices permitting a richer theorizing by "being bolder in our theorizing and more innovative and rigorous in our treatment of data" (Grover and Lyytinen 2015, p. 271). Consequently, it can be assumed that digital innovation research will be increasingly present on the IS research agenda.

Digital Innovation Research

Digital innovation research is already an established field of IS research as the following brief overview shows: Lucas and Goh conduct a case study why Kodak missed the transformation to digital

photography (Lucas and Goh 2009). Building on Christensen's disruptive innovation theory, Kaltenecker et al. (Kaltenecker et al. 2015) examine the disruptive change for software companies while transforming from on premise to on-demand. Nolan et al. conduct a case study on the development of an aircraft, Boeing's 'Dreamliner' 787 and highlight the organizational implications of technological change in context of product innovation (Nolan 2012). More related to the IT function, Grisot et al. focus on innovation in infrastructure (Grisot et al. 2014) while Lyytinen et al. analyze the impact of product innovation on knowledge creation and sharing in innovation networks (Lyytinen et al. 2016). Aubert et al. look at innovation in the outsourcing context (Aubert et al. 2015).

Dynamic capabilities play an important role to flexibly react to an increasingly rapid changing environment: Karimi et al. focus on the role of dynamic capabilities in responding to digital disruption with a comprehensive case study about the newspaper industry (Karimi and Walter 2015). Pavlou et al. perceive dynamic capabilities as a source of competitive advantage (Pavlou and El Sawy 2010) while El Sawy et al. describe digital transformation as a "messy, complex, and chaotic phenomenon" consisting of a simultaneous increase in environmental turbulence, speed of organizational change, and the intensified ubiquity of digital technologies (El Sawy et al. 2010).

The concept of organizational ambidexterity complements dynamic capabilities theory and postulates to build up different skills. O'Reilly and Tushman perceive organizational ambidexterity as a dynamic capability to resolve Christensen's Innovators Dilemma (O'Reilly and Tushman 2008). Garcia-Lillo and O'Reilly and Tushman provide comprehensive overviews on literature regarding organizational ambidexterity in context of digital transformation (Garcia-Lillo et al. 2016; O'Reilly and Tushman 2013). More related to IT, the concept of contextual ambidexterity developed by Gibson and Birkinshaw provide a well-fitting theoretical concept to the practitioners' notion of "bimodal IT" (Gibson and Birkinshaw 2004).

The software development method 'agile' has a long tradition within IS and is now understood by practitioners as a more general concept to increase flexibility in IT. While Cram et al. perceive 'agile' as a management fashion (Cram and Newell 2016), some articles deal with the transformation of an organization to become fully agile: Lowry et al. examine on how to make an organization agile through IT (Lowry and Wilson 2016), Kniberg et al. look at success factors of Spotify's fully agile organization (Kniberg 2012). Rigby et al. elaborate on the key elements when 'agile' is applied to organizations (Rigby et al. 2016). However, an application of 'agile' to structure and governance of IT has not taken place so far to the best knowledge of the author.

Quite many publications deal with digital innovation and digital strategy: Bharadwaj et al. address aspects of scope, scale, speed, and source for a digital strategy (Bharadwaj et al. 2013). El Sawy et al. describe how Lego has transformed its business model towards digital leadership (El Sawy et al. 2016). Hansen and Sia look at Hummel's digital strategy (Hansen and Sia 2015) and Hess et al. develop options for formulating a digital strategy based on three cases in the media industry (Hess et al. 2016).

These examples on digital innovation research show that digital strategy and digital transformation are already well present on the scholar IS research agenda.

Research on the Impact of Digital Transformation on IT outside the "Basket of Eight"

While digital transformation significantly impacts IT, research related on how to make an IT organization future-proof for effectively providing digital technologies is still rare. Even though not focused by IS research, managerial or structural aspects of the IT function are well present. Consequently, the question arises on how digital transformation impacts these topics and of whether existing concepts and recommendations need to be adapted.

The following section focuses research on the impact of digital transformation outside the "Basket of eight". Related publications within the "Basket of eight" are presented in the 'Results' section.

Horlach et al. show in a comprehensive literature review on "bimodal IT" that just one scientific publication exists as of August 2015 while there is a wide range of publications in practitioner literature (Horlach et al. 2016). "Bimodal IT" refers to the coexistence of traditional IT with digital IT implying that an IT organization needs to manage both for successfully managing the digital transformation and relies on the concept of organizational ambidexterity.

Bygstad's paper "The Coming of Lightweight in IT" is according to Horlach et al. the first academic paper on "bimodal IT" and applies the concepts of generativity and loose coupling to "bimodal IT"

(Horlach et al. 2016). According to Bygstad, "heavyweight IT" refers to traditional systems and databases that become more sophisticated and expensive as they become more integrated with other systems (Bygstad 2015). Contrary, "lightweight IT" would be the new paradigm of mobile apps, sensors and bring-your-own-device, also called consumerization or internet of things. Both modes need to be connected without hindering the generative attributes of each other (Bygstad 2015).

Haffke et al. deal with aspects of "bimodal IT" and extend Bygstad's work to questions of the organizational structure. Based on IT executive survey data they analyze how "bimodal" structures are implemented in IT organizations. One of the key findings is that "bimodal IT" would serve as a transition state towards a fully agile IT organization (Haffke et al. 2017).

Methodology

This paper conducts a bibliometric study on all articles published between January 2007 and December 2016 in the AIS Senior Scholars 'basket' of eight leading IS journals. The empirical analysis of articles published in leading IS journals is an established method of studying IS research (Chen and Hirschheim 2004; Grover and Lyytinen 2015; Sørensen and Landau 2015). The "Basket of eight" has been selected in order to have a representative sample for journals of high reputation among IS scholars focusing on mainstream IS research. Objective is to analyze to which extent digital innovation research in general and specifically related to the impact of digital transformation on IT is already covered by leading IS journals.

This paper applies Sørensen and Landau's methodology (Sørensen and Landau 2015) to recent digital innovation research. An accompanying literature search on relevant 'digital' literature has been conducted according to vom Brocke et al. and Webster and Watson (Vom Brocke et al. 2009; Webster and Watson 2002).

The limitation on the "Basket of eight" as representative journals for mainstream IS research can be criticized for good reasons and has been subject to discussions in the IS community (Willcocks et al. 2008). Consequently, the analysis excludes publications in other IS or interdisciplinary journals, IS conferences, or dissertations.

The limitation on the "Basket of eight" has been chosen besides of reasons for methodological consistency with Sørensen and Landau for three reasons: First, the "Basket of eight" reflects a representative sample for 'mainstream' scholar IS research due to its high acceptance in the IS community. This is because the scientific debate is mainly conducted through peer-reviewed journal publications (Galliers and Whitley 2007; Stein et al. 2016; Willcocks et al. 2008). While newer research topics are often discussed on conferences and topics related to managerial or operational aspects of technology can be found predominately in journals targeting a practitioner audience, the "Basket of eight" serves as a well-established indicator on how new topics become part of the mainstream scholar research agenda. According to Sørensen and Landau "including outlets relying less on a rigorous peer review process many undoubtedly have demonstrated speed in exploring new phenomena but would not have allowed the study of both speed and rigor" (Sørensen and Landau 2015, p. 162). Second, the "Basket of eight" is a representative choice for journals covering the scholar IS discussion since all are international journals provide a representative regional coverage with four journals from the US (ISR, JAIS, JMIS, and MISQ) and four journals from Europe (EJIS, ISJ, JSIS, and JIT). Third, the "Basket of eight" consists of journals focusing on IS topics only.

The "Basket of eight" consists of the following journals (alphabetically ordered):

- European Journal of Information Systems (EJIS, ISSN: 0960-085X);
- Information Systems Journal (ISJ, ISSN: 1365-2575);
- Information Systems Research (ISR, ISSN: 1047-7047);
- Journal of Information Technology (JIT, ISSN: 0268-3962);
- Journal of Management Information Systems (JMIS, ISSN: 0742-1222);
- Journal of Strategic Information Systems (JSIS, ISSN: 0963-8687);
- Journal of the Association of the AIS (JAIS, ISSN: 1536-9323);
- MIS Quarterly (MISQ, ISSN: 2162-9730).

The bibliometric study takes the number of published articles as a measure for the extent of research on the phenomenon within mainstream IS discussion. Essentially, it counts all relevant articles published in the "Basket of eight" related to digital innovation in general and specifically to the impact of digital transformation on IT. If the article seemed to be relevant, the paper has been downloaded for further examination regarding relevance. Research articles, guest editorials, introductions to a

journal's special issue, research notes, and research commentaries have been included. General editorial notes, book reviews, errata, responses to previous publications, teaching cases, author index, research index, and acknowledgements have been excluded from the count since these publication types are usually not used for communication of new research results.

Digital transformation is mainly prevalent in the CIO discussion since the emergence of digital technologies. The time frame of the bibliometric study has been limited for this reason to the last ten years, specifically from January 2007 to December 2016. The limitation regarding the time frame can be justified with the finding that the majority (81%) of all identified articles has been published between 2012 and 2016 whereas just 19% of all identified articles have been published between 2007 and 2011. Just three articles at all could be identified between 2007 and 2009.

Identified articles have been classified for relevance according to the following criteria: All articles directly addressing the topic of the impact of digital transformation on IT have been classified as "relevant". Examples include articles covering topics of digital technologies or digital transformation in context with IT. Articles related to either the topic of digital transformation, digital strategy, digital technologies but not in context with the IT function have been classified as "partly relevant". Examples include articles on digital technologies like business analytics or cloud computing, digital strategy, or on the future role of the CIO.

This bibliometric study differs from Sørensen and Landau's work in three minor respects: First, this study has a slightly wider definition of articles included. Sørensen and Landau exclude guest editorials and introductions to special issues. This study has taken them into account since they contain opinions or contributions relevant for further development of research. Second, this bibliometric study classifies articles as "relevant" or "partly relevant". This distinction has been made because of the low number of identified relevant articles. The category "partly relevant" has been introduced to take a wider range of articles into account that are also related to digital transformation and digital technologies in general. Therefore, unlike Sørensen and Landau, this paper does not restrict digital innovation research to a comparatively strict definition like mobile ICT, but also takes various aspects of digital innovation, digital strategy, and digital technologies into account. Third, this study uses a different, more recent time frame of 2007-2016, whereas Sørensen and Landau have used the time frame between 2000 and 2014. As already mentioned, the vast majority of relevant and partly relevant articles has been published as of 2012.

Results

A bibliometric study analyzing all articles published in the "Basket of eight" between 2007 and December 2016 has been conducted for identifying to which extent digital innovation research is already covered by leading IS journals.

An examination of titles, abstracts, and key words of all 2,833 articles published in the "Basket of eight" between January 2007 and December 2016 has retrieved five articles covering the aspects of the impact of digital transformation on IT. These articles have been classified as "relevant". Additional 64 articles have been identified that cover general topics of digital transformation, digital strategy, or digital technologies but not related to IT. These articles have been classified as "partly relevant". Relevant and partly relevant articles account for a total of 0.2% respectively 2.3% of all articles published in the "Basket of eight" between January 2007 and December 2016.

Table 1. Articles on the impact of digital transformation on IT by year published							
Year	Total [#]	Partly relevant [#]	Relevant [#]	Partly relevant as % of total	Relevant as % of total	Partly relev. % of total partly relevant	Relevant total % of total relevant
2016	277	8	2	0.3%	0.1%	12.5%	40.0%
2015	269	6	3	0.2%	0.1%	9.4%	60.0%
2014	308	8	0	0.3%	0.0%	12.5%	0.0%
2013	302	20	0	0.7%	0.0%	31.3%	0.0%
2012	338	9	0	0.3%	0.0%	14.1%	0.0%
2011	301	3	0	0.1%	0.0%	4.7%	0.0%
2010	287	7	0	0.2%	0.0%	10.9%	0.0%
2009	230	2	0	0.1%	0.0%	3.1%	0.0%
2008	258	0	0	0.0%	0.0%	0.0%	0.0%
2007	263	1	0	0.0%	0.0%	1.6%	0.0%
Total	2,833	64	5	2.3%	0.2%	100%	100%

As can be seen from Table 1, all five relevant articles have been published in 2015 or 2016. This shows that despite of being a comparatively young topic in scholar IS research, digital innovation research related to the IT function entered the mainstream IS research agenda recently.

The publication peak of partly relevant articles is in 2013 with 20 articles representing 31.3% of all partly relevant articles. This is due to special issues in ISR and MISQ: A special issue in ISR on social media and business transformation in volume 24, issue 1 (March 2013) covers a total of five partly relevant articles. A special issue in MISQ on digital business strategy in volume 37, number 2 (June 2013) contains six partly relevant articles.

81% of all partly relevant articles have been published between 2012 and 2016 indicating that 'digital' topics have already been present also in mainstream IS journals since a couple of years. Few publications are from earlier than 2011 – 13 partly relevant articles (20%) have been published between 2007 and 2011 and just one article has been published between 2007-2008.

Table 2 shows the number of total, relevant, and partly relevant articles per journal and region.

Table 2. Number of publications per journal and region								
Journal	5 year impact factor 2015 (Thomson Reuters)	Articles total [#]	Articles partly relevant [#]	Articles relevant [#]	Articles as % of total articles	Articles partly relevant as % of total	Articles relevant as % of total articles	Articles as % of all partly relevant and relevant
MISQ	9.51	449	15	0	16%	0.5%	0.0%	21.7%
ISR	4.01	454	17	2	16%	0.6%	0.1%	27.5%
JMIS	3.78	431	4	0	15%	0.1%	0.0%	5.8%
JAIS	2.73	330	5	0	12%	0.2%	0.0%	7.2%
	5.01							
USA total		1,664	41	2	59%	1.4%	0.1%	62.3%
			1.4%	0.1%		0.0%	0.0%	
JIT	6.19	283	7	1	10%	0.2%	0.0%	11.6%
JSIS	3.49	196	4	2	7%	0.1%	0.1%	8.7%
ISJ	3.17	237	6	0	8%	0.2%	0.0%	8.7%
EJIS	3.01	453	6	0	16%	0.2%	0.0%	8.7%
	3.96							
EU total		1,169	23	3	41%	0.8%	0.1%	37.7%
			0.8%	0.1%				
Grand Total "Basket of eight"		2,833	64	5	100%	2.3%	0.2%	100%
			2.3%	0.2%				

As can be seen from Table 2, this bibliometric study reveals insights on the split of articles according to journal, region and impact factor:

- Most identified partly relevant and relevant articles have been published in US journals (62.3 %) compared to 37.7% published in European journals.
- Three out of the total of five relevant articles have been published in European journals while the other two articles have been published in US journals. Relevant articles have been published in journals with a comparably high 5-year impact factor as of 2015 according to Thomson Reuters – JIT (6.19), ISR (4.01), and JSIS (3.49).
- Most identified articles have been published in high-ranked journals MISQ and ISR: The highest overall coverage of all partly relevant and relevant articles has the US-journal ISR with 27.5% - in total 17 partly relevant and two relevant articles. Within the "Basket of eight", ISR is the third-highest ranked journal with an impact factor of 4.01. The top-ranked US-journal MISQ with an impact factor of 9.51 comes second regarding article coverage with a total of 22% of all partly relevant articles. The high article coverage in ISR and MISQ is due to special issues related to digital transformation in 2013 clearly demonstrating that 'digital' topics are on the mainstream research agenda in top-ranked IS journals.
- The European journal JIT comes third regarding article coverage with a total of seven partly relevant and one relevant article. JIT is the second-highest ranked journal in the "Basket of eight" with an impact factor of 6.19 and the highest-ranked journal of European origin in the "Basket of eight".
- Two US journals have the overall lowest article coverage: JMIS with a total of four partly relevant articles (5.8%) and JAIS with a total of five partly relevant articles (7.2%). Of all journals in the "Basket of eight", JAIS is lowest-ranked with an impact factor of 2.73. JMIS has an impact factor of 3.78.

The identified relevant articles are briefly introduced as follows: These articles cover topics of agility, innovation, or organizational ambidexterity: Gregory et al. conduct a multiyear case study to discover aspects of organizational ambidexterity in context of IT transformation programs (Gregory et al. 2015). They identify areas where organizational ambidexterity can be expected and give recommendations on how to handle them (Gregory et al. 2015). Lee et al. analyze the relationship between organizational ambidexterity and agility. This is one of the few articles explicitly dealing with organizational ambidexterity in context of IT. By using large-scale survey data, the authors conclude that a firm's IT ambidexterity capabilities enhance organizational agility (Lee et al. 2015). Lowry et al. deal with another aspect of organizational agility: They address the question on how organizational agility can be improved by IT. The authors develop a theoretical model relating an organization's internal IT service perceptions to IT agility and verify the hypothesis that a service perception of the internal IT positively affects IT agility (Lowry and Wilson 2016). Both, Kaltenecker et al. and Kumar et al. address topics of organizational change management: Kaltenecker et al. examine the disruptive potential of cloud computing. They apply Christensen's disruptive innovation theory and derive implications of disruptive change from 'on-premise' to 'on-demand' (Kaltenecker et al. 2015). The editorial of Kumar et al. is the introduction to a special issue titled "Exploring Enterprise Social Systems & Organizational Change: Implementation in a Digital Age" in Volume 31, issue 2 (June 2016) of JIT. The authors conduct a comprehensive literature review on enterprise social systems and elaborate on the challenges for organizational change and the implications for IT (Kumar et al. 2016).

One objective of this study is to compare results with the findings of Sørensen and Landau and to assess the coverage of 'digital' innovation research as of 2015 and onwards that has not been covered by Sørensen and Landau. While this bibliometric study reveals roughly a comparable percentage of articles relevant to the selected reference topic of digital innovation research (Sørensen and Landau – mobile ICT: 3.2%; this study – impact of digital transformation on IT and related topics of digital technologies and strategy: 2.5%), the findings of this study differ quite substantially from Sørensen and Landau in three aspects: First, the finding of Sørensen and Landau that 'elite' IS journals tend to be less open towards new topics of digital innovation research (Sørensen and Landau 2015) cannot be confirmed for the subject of this study: Major reasons are publications of all relevant articles in 2015 and 2016 and a large number of publications following the specials issues of ISR and MISQ in 2013. This implies that topics of digital innovation research find now successively their way into leading IS journals. Second, and also contrary to the findings of Sørensen and Landau, journals with a high reputation have a higher topic coverage compared to lower ranked journals: The top four ranked journals MISQ, ISR, JMIS, and JIT cover 67% of all identified articles whereas the bottom four ranked journals in the "Basket of eight", JSIS, ISJ, EJIS, and JAIS, cover 33% of all identified articles. Third, this bibliometric study finds that the majority of the articles identified comes from US journals (62.3%), whereas articles in European journals cover 37.7% of all identified articles. Sørensen and

Landau found that the majority of identified articles has been published in – lower ranked – European journals. An explanation would be that lower-ranked journals could be more innovative because they need to be less concerned about mainstream research (Sørensen and Landau 2015). Since the impact factor is measured by citations in academic publications, a higher impact factor is associated with more citations indicating that the article's topic is likely to be closer to mainstream scientific research.

However, an overall 2.5% identified articles covering topics of 'digital' innovation research in the "Basket of eight" is still not much for a topic with high attention among practitioners (Urbach 2016) and in a research field being exposed to contemporary fashions (Baskerville and Myers 2009; Cram and Newell 2016; Wang 2010).

As additional illustration for the gap between topic attention in science and practice and following the approach of Sørensen and Landau, a cross-check for hits of specific 'digital' terms in scientific and non-scientific databases has been conducted. The insight of such a study is limited and one could question its sense at all. It has been included in this study since the results confirm previous findings: Both, academics, and practitioners use specific terms regarding selected 'digital' topics and they do not necessarily use the same language. But even if 'digital' search terms are used by both, scientists and practitioners synonymously, there is a significant gap between search results in scientific and non-scientific databases like Google.com: Search results in scientific databases are always significantly smaller compared to Google since academic databases do not contain advertisements or information on product or service offerings. Consequently, the absolute difference in search results for one search term across the different data bases is of limited insight. There is however a meaning if significant differences in search results across different search terms exist.

A search on selected 'digital' terms has been conducted in the databases Metasearch (https://www.ebscohost.com), Web of Science (https://apps.webofknowledge.com), JSTOR (www.jstor.org), Google Scholar (http://scholar.google.com), and in Google (www.google.com). The search has been conducted for selected 'digital' terms like "agile" or "digital strategy" that are used in both, science and practice. A cross-check has been performed with expressions that are more common in science, like for example the term "ambidexterity", or that are mainly used in practice, like for example the term "digital disruption". Search results from scientific databases have been compared with search results from Google. Google Trends have been included for a better understanding of trend development regarding the search terms over time.

Table 3. Results of exemplary 'digital' search hits for selected databases and websites - search conducted on 20.04.2017

Search Term	Metasearch Ebsco (http://eds.b.ebscohost.com)	Web of Science (https://apps.webofknowledge.com)	JSTOR (www.jstor.org)	Google Scholar (www.scholar.google.com)	Google.com (www.google.com)	Google search trends (www.trends.google.com)
"Bimodal IT"	25,014	7,659	7,654	599,000	3,950,000	Declining since mid 2016
"Two speed IT"	255,316	51,677	215,228	4,030,000	51,400,000	Constant interest with high variance
"Agile"	77,869	12,251	9,074	616,000	84,300,000	Slightly increasing interest
"DevOps"	1,252	131	2	5,620	18,000,000	Steady growth since 2012
"Ambidexterity"	38,320	935	443	18,600	317,000	Constant interest with high variance
"Digital strategy"	135,943	16,751	19,486	3,320,000	22,200,000	Constantly increasing interest
"Digital IT architecture"	6,133	7,897	9,664	2,450,000	473,000,000	Constant interest
"Digital transformation"	48,517	8,469	14,627	2,830,000	13,600,000	Strong growth since 2016
"Digital technologies"	955,088	63,595	20,848	3,320,000	38,900,000	Constant interest
"Digital disruption"	6,024	920	2,030	507,000	45,900,000	Strong growth since 2015

As can be seen from Table 3, scientific databases return roughly similar hits for exemplary 'digital' expressions with Metasearch Ebsco returning generally more search results than Web of Science or JSTOR. Google Scholar returns significantly more hits than the three other scientific databases. Google.com returns for all search termini a multiple of search hits compared to the scientific databases. Google.com can be taken as a reference for a non-scientific database.

The following results are noteworthy:

- Some terms that are clearly used in either scientific or practice-related context: The search term "ambidexterity" returns in Google.com 'only' approx. eight times more search results compared to Ebsco Metasearch. Contrary, the search term "bimodal IT" is mainly used among practitioners with comparably few hits in academic databases whereas the corresponding scientific term "two speed IT" returns also a significant number of hits in scientific databases.
- The somehow blurred term "digital disruption" is mainly used by practitioners and not academics. Surprisingly, the term "digital transformation" has a comparatively high coverage in scientific context.

- "DevOps" is in academics in contrast to the term "agile" so far almost not present despite of being closely associated with agile methods and ambidexterity.

Figure 1 visually displays the search results from Google Scholar and Google.com for exemplary 'digital' search terms. The matrix dimensions "innovation/digitalization" and "global operational backbone" serve for reasons of better visualization. The absolute size of the bubble represents the number of search hits and can be used as a proxy for topic relevance.

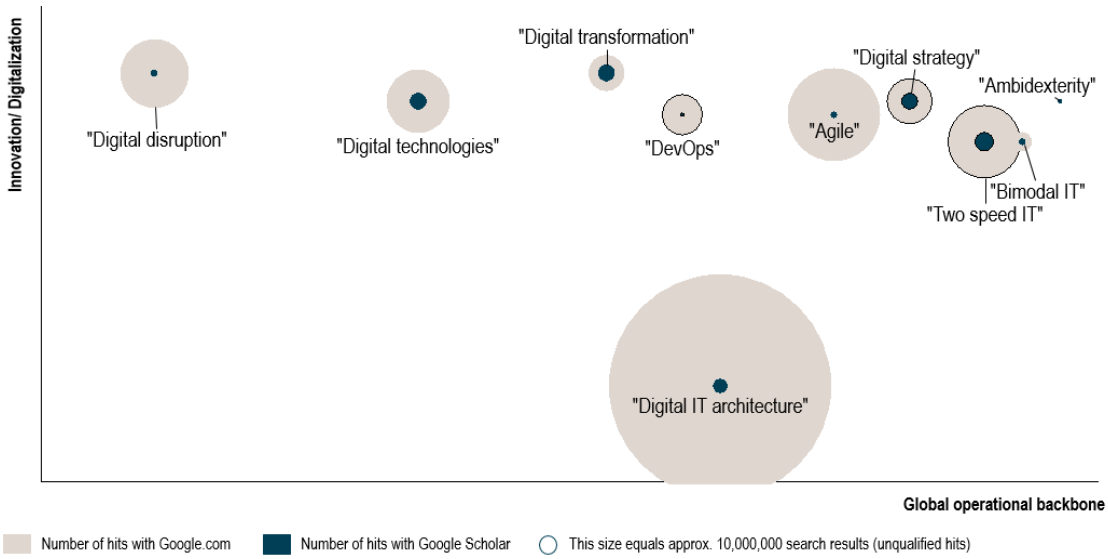

Figure 1. Search results for selected 'digital' terms at Google Scholar and Google.com – search conducted on 20.04.2017.

"Digital IT architecture" followed by "agile" retrieve most hits on Google whereas "ambidexterity" and "bimodal IT" retrieve the fewest hits on Google. Terms with comparably similar topic coverage in academics and practice include "digital transformation", "digital strategy", or "two speed IT". "Digital disruption", "DevOps" or "agile" are comparably widespread in practice while not in academics, whereas "bimodal IT" or "ambidexterity" play only a niche role in both, science and practice.

This analysis comes with limitations: The number of unqualified hits is only a rough proxy for the quality of search results and therefore should not be overrated. Furthermore, Google.com includes search results for product and service offerings of suppliers and advertisements. Consequently, the number of search results serves only as a rough indication for topic relevance and is in vast contrast with the comparably limited number of search hits in primarily scientific databases (Horlach et al. 2016; Sørensen and Landau 2015).

Discussion

A bibliometric study analyzing all 2,833 papers published in the "Basket of eight" between January 2007 and December 2016 has been conducted. Result is that a mere 2.5% of all articles are related to topics of digital transformation, innovation, strategy, or technologies. Just five articles (0.2%) address the impact of digital transformation on IT.

81% of all identified articles have been published since 2012 and the identified five articles addressing the impact of digital transformation on IT have been published in 2015 or 2016.

This study comes to different results regarding latest publication trends compared to Sørensen and Landau: Contratry to their findings, the majority of all identified articles (62.3%) has been published in journals of US origin. Also contrary to Sørensen and Landau, the majority of all identified articles has been published in high-ranked journals – MIS Quarterly, ISR and JIT cover alltogether 60.9% articles. Consequently, Sørensen and Landau's finding that 'elite' IS journals tend to be less open towards new topics of 'digital' innovation research (Sørensen and Landau 2015) cannot be confirmed for the subject of this study.

This bibliometric study comes with the limitation that the "Basket of eight" has been chosen as empirical context. Reason is that the "Basket of eight" enjoys a high acceptance among researchers, it focuses on IS topics exclusively and it has a representative regional coverage with four US and four European journals. Due to a comparatively high impact factor of the journals, the "Basket of eight" serves as a representative and valid indicator for the degree to which new topics like digital innovation have already become part of the mainstream IS research agenda.

Extending the bibliometric study to journals outside the "Basket of eight" would confirm the hypothesis that journals focusing practitioners or a general business audience have a higher topic coverage: MIS Quarterly Executive has a stunning overall topic coverage of 29.5% with 12 relevant and 39 partly relevant articles between 2007 and 2016. The German journal 'HMD – Praxis der Wirtschaftsinformatik' has a total of 10.1 % partly relevant or relevant articles out of all 348 published articles between 2012 and 2016. MIT's Sloan Management Review targeting a more general business audience comes to an impressive 23.8% of partly relevant articles out of the 294 articles published between 2012 and 2016 covering all different aspects of digital strategy, innovation, and technology. With respects to conferences, ICIS as an example for a highly-ranked IS conference has an impressive topic coverage of 25.3% in 2016.

This bibliometric study has implications for future research and for the role of IS research in general: For future research, an extension of the analysis beyond the "Basket of eight" with selected focus e.g. on practitioner-related journals or conferences only could provide additional insights on the early stage of adapting digital innovation research and on how new topics find their way in the mainstream IS research agenda. Furthermore, due to the fact that articles in high-ranked journals have a longer lead time for publication because of more extensive review-cycles, it would be interesting to learn on how topic coverage evolves in the future. More recent trends regarding coverage of digital innovation topics within the "Basket of eight" are very encouraging: The highest-ranked journal in the "Basket of eight", MIS Quarterly, has published three partially relevant and one relevant article in just one edition in 2017 (Vol. 41, No. 1, March 2017).

For the role of IS research in general, this study should encourage IS researchers to engage in digital innovation and to further contribute to the discussion and knowledge creation regarding digital innovation topics: The current attention of the digital transformation among practitioners could be used as backwind for further strengthening IS research. As the IT department of a company is predestined to contribute to digital transformation of a company by providing digital technologies for business model innovation with the help of new digital products and services, IS research is predestined to contribute by applying relevant theories to generate further insights likewise. As an example, Bygstad et al., Horlach et al., and Haffke et al. have been the first to address the topic of "bimodal IT" (Bygstad 2015; Haffke et al. 2017; Horlach et al. 2016). But many questions remain like how "agile" and "bimodal IT" are related to organizational ambidexterity or of whether or not DevOps can be seen as a lever for achieving contextual ambidexterity. Furthermore, there is a need to analyze how digital transformation affects existing IS theories, concepts and models that mainly stem from the "pre-digital age". For instance, digital technologies like cloud computing or the internet of things have significant impacts on how software development, operations and service management will be conducted. However, existing IT management models like ITIL or COBIT currently do not reflect implications of digital technologies.

IS research has the tools and methods to make an important contribution to digital transformation. Design Science Research or Design Thinking are just some examples: Both are suitable for analyzing complex or wicked problems like digital transformation and have the power to create useful artifacts of both, practical relevance and theoretical impact. Now IS has to deliver if it does not want to be in the same situation like many IT departments today: Business does not need IT anymore because digital technologies have made business units independent from IT as an exclusive gateway to technology (Urbach 2016). Recent publications on digital innovation research especially in highly ranked IS journals within the "Basket of eight" are very promising – yet more need to come.

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